



Research Report 1970

Tests of a Prior Marksmanship Knowledge Predictor Test

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Northrop Grumman Corporation

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**United States Army Research Institute
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TESTS OF A PRIOR MARKSMANSHIP KNOWLEDGE PREDICTOR TEST

EXECUTIVE SUMMARY

Research Requirement:

The current research examined the use of a marksmanship prior knowledge test as a means of systematically grouping Soldiers for the purposes of rifle marksmanship instruction. Prior knowledge in the context of rifle marksmanship could include knowledge of body position, firearm safety, ballistics, trajectory, windage, and sighting systems. Given the role of such subdomains in marksmanship performance, it stands to reason that the training most beneficial to Soldiers with some knowledge of these topics would differ from the training most beneficial to Soldiers with limited or no knowledge of these areas. Accordingly, we specifically sought to determine whether performance on a prior knowledge test of marksmanship added any predictive power beyond that from simply asking Soldiers if they have experience shooting outside of a military context (e.g., hunting).

Procedure:

In Experiment 1, we tested the relationship between marksmanship prior knowledge and the shooting performance of 54 students across three classes of the Army Squad Designated Marksmanship (SDM) Course. In Experiment 2, we tested whether this same test could predict performance for 184 Soldiers during Infantry One Station Unit Training (OSUT) on the Basic Rifle Marksmanship (BRM) qualification course of fire.

Findings:

We found that prior knowledge did significantly predict marksmanship performance beyond any effects of prior shooting experience outside of the military in both the SDM and BRM groups. However, the effect size for BRM was too small to be useful for effective instructional grouping for BRM.

Utilization and Dissemination of Findings:

Results from the prior knowledge test can be used by SDM trainers to group shooters based on their anticipated performance. Further research and test development is needed to group Soldiers for BRM training according to prior marksmanship knowledge. Results of this research were presented to the leaders and trainers of the SDM course as well as the OSUT unit leaders.

TESTS OF A PRIOR MARKSMANSHIP KNOWLEDGE PREDICTOR TEST

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Tests of a Prior Marksmanship Knowledge Predictor Test

Introduction

Imagine two Soldiers on a firing line in the prone supported position, each armed with an M4 rifle. The first Soldier sends his rounds down range, repeatedly striking the 300-meter target in the center-of-mass, one shot after the other. The second Soldier shoots poorly, sending shots into the dirt, over the shoulder, off to the side, and everywhere else it seems but the target. What does the second Soldier need to do to improve his performance and how can the range time and resources be used to efficiently and effectively change those behaviors?

Many components contribute to marksmanship performance, from body position and cheek-stock weld to sight alignment and trigger control to name a few. While some improvement might arise simply from unguided practice and “more trigger time”, substantial improvement will likely depend on instructor feedback, defined here as the actions taken by the instructor to provide information regarding some aspect of one’s task performance (Kluger & DeNisi, 1996).

All things being equal, instruction that consistently and systematically corrects specific performance issues should be expected to yield the greatest improvements in outcomes across skill levels (Ericsson, 2006). Because the sources of marksmanship performance errors typically differ across Soldiers, instructors would ideally select the instructional action that best addresses a specific element of each Soldier’s shooting performance, in essence, tailoring training to that specific individual. Such one-on-one tutoring has yielded positive performance outcomes of varying strength across a range of tasks (Bloom, 1984; VanLehn, 2011).

At the broadest level then, the core idea of tailored training is that salient individual differences related to performance can be used to assign learners to learning conditions (Schaefer, Blankenbeckler, & Lipinski, 2011). In the case of one-on-one instruction, this may be simple enough provided the instructor can identify and correct performance issues. Things get more challenging, however, as the size of the instructional group increases for one simple reason: the instructor feedback that helps one individual might not help another. Returning to our two shooters as an example, providing simultaneous instruction to both Soldiers about sight alignment is unlikely to benefit the first Soldier who displayed consistent, accurate shot placement; only the second Soldier exhibiting erratic performance might stand to benefit from additional instruction on sight alignment. Expanding this example to larger groups such as a platoon or company, one can see that the number of individuals who fail to gain from additional instructional input increases as the size of the instructional group increases. In light of the Army’s throughput challenges and frequent need for massed training, how might the advantages of tailored training practically be brought to bear on Army marksmanship training?

Importantly, tailored training not only includes fine-grained, micro-level instruction such as one-on-one tutoring but also macro-level, group-based interventions such as ability or knowledge-based instructional groupings (Schaefer & Dyer, 2012). The present paper focuses on tailoring training according to prior domain knowledge, defined here as the information, facts, and procedures required for successful performance (Chen & Paul, 2003; see also Schaefer &

Dyer, 2012). Using differences in prior knowledge for the purpose of creating different instructional groups has three advantages. First, prior knowledge folds in the contributions of both general mental ability and prior experience to task performance (Schmidt & Hunter, 1992). As a result, it stands as a potentially efficient source of predictive performance discrimination relevant for marksmanship and skill learning. Second, tests of prior knowledge can be effectively administered to large groups with paper-and-pencil or online assessments. Finally, prior knowledge assessments and groupings have a long and established history within Army training (Zeidner & Drucker, 1987). Indeed, U.S. Army history is rife with examples of aptitude testing to classify Soldiers for military training, beginning as early as World War I and continuing today during the assessment of Soldiers into the Army (Defense Manpower Data Center, 2012; Colman, 2009). The application of massed testing for the purposes of instructional groupings is thus broadly consistent with previous and current Army training cultures.

Considerations of effectively tailored training and increased training efficiency for marksmanship are also particularly apt in the context of the Army Learning Concept 2015, which prescribes the use of pre-assessments to group Soldiers and tailor training (U.S. Army Training and Doctrine Command, 2011). However, research conducted by Dyer, Wampler, and Blankenbeckler (2011) identified that even though examples of tailored training were present in Army courses, the use of pre-assessments to group Soldiers by ability, experience, and/or prior knowledge was non-existent. In instances where Soldiers were grouped for the purposes of instruction, the grouping was done according to arbitrary criteria (e.g., by seating arrangement, rank, combat experience, or by perceived prior knowledge), not on the basis of formal training templates or performance models. In addition, it is also worth noting that many Army courses emphasize more abstract skills such as leadership or adaptive decision making which may be harder to quantify. Marksmanship is an ideal domain to examine group-based tailored training because performance fundamentals are well-established and performance measures can be objectively quantified.

The current research examines the use of a marksmanship prior knowledge test as a means of systematically grouping Soldiers for the purposes of rifle marksmanship instruction. Prior knowledge in the context of rifle marksmanship could include knowledge of body position, firearm safety, ballistics, trajectory, windage, and sighting systems. Given the role of such subdomains in marksmanship performance, it stands to reason that the training most beneficial to Soldiers with some knowledge of these topics would differ from the training most beneficial to Soldiers with limited or no knowledge of these areas. This suggestion is consistent with aptitude-by-treatment interaction (ATI) research (Snow, 1992; see also Schaefer & Dyer, 2012), in which the effects of different instructional treatments differ according to student aptitude (operationalized typically as prior knowledge, experience, or general mental ability).

Accordingly, we specifically sought to determine whether performance on a prior knowledge test of marksmanship added any predictive power beyond that from simply asking Soldiers if they have experience shooting outside of a military context (e.g., hunting). In Experiment 1, we tested the relationship between marksmanship prior knowledge and shooting performance in the Army Squad Designated Marksmanship (SDM) Course, which trains individuals to hit targets at a distance of 300 meters and 600 meters. Because individuals in the SDM course are typically more senior (E-5 and above), Experiment 1 provides a test of whether

the prior knowledge test usefully predicts the shooting performance of experienced Soldiers. In Experiment 2 we tested whether this same test could predict performance on the Basic Rifle Marksmanship (BRM) qualification course of fire for those completing their initial entry training and thus new to the Army. To preview our results, we found that prior knowledge did significantly predict marksmanship performance beyond any effects of prior shooting experience outside of the military in both the SDM and BRM groups. However, the effect size for BRM was too small to be useful for effective instructional grouping for BRM. Subsequent analysis and discussion address these outcomes and provide some indicators for possible additional future research.

Experiment 1

Experiment 1 examined the relationship between tests of Prior Knowledge and performance in a variety of shooting tasks in the SDM Course taught by the U.S. Army Marksmanship Unit (USAMU). The purpose of this initial experiment was to determine whether a test of prior domain knowledge in marksmanship would significantly predict later shooting performance. Evidence of a significant and behaviorally meaningful relationship would support the viability of prior knowledge as a basis for grouping individuals for the purposes of instruction.

Method

Course Selection. ARI, through coordination with the USAMU SDM Course leader, selected four SDM classes to participate in this research (see Table 1). The changes from a 5-day to a 10-day course included the addition of instruction and practice on iron sights and an increase in the total number of rounds fired. We conducted training observations of the first class to determine how to best integrate ourselves into the course to collect the desired data without hindering the execution of the class. Additionally, this gave us the opportunity to pilot instruments developed initially, and to modify both based on SDM instructor feedback and practical application. We refined our data collection procedures and instruments in preparation for the collection effort for the final three classes.

Table 1
SDM Classes

Date	Class #	# of Students	Type	Research Effort
12-16 Sep 2011	NA	NA	5-day	Observation
28 Nov – 9 Dec 2011	12-1	37	10-day	Data Collection
30 Jan – 10 Feb 2012	12-2	32	10-day	Data Collection
19-30 Mar 2012	12-3	33	10-day	Data Collection

Participants. The SDM course is open to service members of any branch of the Department of Defense; Army, Navy, Air Force, or Marine. Students participating in the three documented classes were assigned to the Army. Soldiers in the Squad Designated Marksmanship course have

usually demonstrated their proficiency with the M16/M4 series rifle and typically attend the course prior to or immediately after being assigned to a Platoon SDM position. Other Soldiers with variable marksmanship backgrounds may also attend, however, when additional course slots are available. This increases the range of skills and ranks of those in the present research. A total of 102 students participated in the three 10-day classes; the number and characteristics of students varied by class. Table 2 summarizes the basic demographics for these classes. Overall, 74% of the enlisted Soldiers were noncommissioned officers (NCOs), while 87% of the officers were lieutenants. A complete summary of student demographics is contained in Appendix A; item numbers with opened-ended responses are not included in this summary.

Table 2
Summary Demographics for Classes 12-1 through 12-3

Demographic	Number (<i>n</i> = 102)	Range
Rank		
Enlisted	87	PV2 (E2) – SFC (E7)
Officer	15	2LT (O1) – COL (O6)
Time in Service	102 months (avg)	6 months - 24 years
Functional Area¹		
Maneuver and Fires	75	
Operations Support	16	
Force Sustainment	11	
Service Status*		
Active Duty	95	
Active Guard Reserve (AGR)	6	

* - One student left the service status blank.

Note: PV2 = Private E-2; SFC = Sergeant First Class; 2LT = Second Lieutenant; COL = Colonel.

Data Collection Instruments. The research team developed, reviewed, and revised instruments with input from the USAMU NCOs. Instrument validation was conducted during the September 2011 SDM class and resulting refinements were made in preparation for the follow-on classes. The instruments consisted of a background questionnaire (see Appendix A) and a marksmanship prior knowledge test (Appendix B).

Background questionnaire. The background questionnaire contained four sections: demographic information, reason for course attendance, equipment, and marksmanship experience. The demographic section consisted of seven questions focusing on military personnel information (e.g., rank, branch of service, time in service, number of deployments),

¹ The Army military occupational specialties/branches (jobs) are categorized into three divisions; Maneuver and Fires Division (MFD), Operations Support Division (OSD), and Force Sustainment Division (FSD). The MFD contains the Air Defense Artillery, Armor, Aviation, Field Artillery, Infantry, and Special Operations Forces branches. The OSD contains the Military Intelligence/Language, Chemical, Engineer, Military Police, and Signal branches. The FSD contains the Health Services, Ordnance, Quartermaster, Soldier Support, and Transportation branches.

while three questions related to identifying any cross-domination between the shooting hand and shooting eye, i.e. shooting right-handed but left-eye dominant. The course attendance section consisted of 11 questions; six focused on students' reason for attending the course as well as their expectations for the course.

Five attitudinal questions related to the students level of motivation and interest in the course. These questions were based on a 7-point sliding scale anchored in the following manner; motivated – unmotivated; dreading it – looking forward to it; interested – uninterested; excited – unexcited; and important – unimportant; the summary motivational measure was not related to shooting performance in the preliminary analysis and is not therefore further considered in the present research (see also Procedure for related information). Four questions in the equipment section focused on identifying the type of rifle and sights the student would use throughout the course. The last section contained seven questions about marksmanship experience in both military and civilian contexts. To retain a tight focus on the current issue of prior knowledge and the practical application of grouped instructions, the analysis in the present paper focuses solely on the question asking if the Soldiers shoot outside of the military context (e.g., hunting, recreational).

Marksmanship Prior Knowledge Test. The 25-item marksmanship prior knowledge test was constructed to determine the student's level of BRM knowledge at the beginning of the SDM course. The test questions were modeled on Chung's et al. prior knowledge test (2004) and a USAMU SDM knowledge test administered later in the course. The test required students to match descriptive definitions with doctrinal terms and to indicate their understanding of ballistics, minutes of angle (MOA), iron and optical sight use, and the effects of wind on the trajectory of the bullet. All participants completed the full 25-item test.

In light of the practical aim of identifying a valid test for instructional groupings, we used this prior knowledge test in two ways. First, we treated the initial 9-item, term-matching portion as a short, self-contained prior knowledge assessment. Testing this "Short Form" version of prior knowledge as a possible stand-alone test is worthwhile because it covers a broad range of basic marksmanship concepts and is also easier to administer relative to the full 25-item test. Second, we also tested the complete 25-item test (inclusive of the nine "Short Form" items) to determine whether the more advanced questions testing concepts like MOA adjustments and round strike location provide additional predictive strength for the prior knowledge measure. Throughout the remainder of this paper, the Prior Knowledge "Short Form" test refers only to the first nine items of the prior knowledge test; the Prior Knowledge "Long Form" test refers to the full 25-item test.

Procedure. In the course of this research effort the SDM program of instruction (POI) was changed from a 5-day to a 10-day course increasing the amount of training time. Because the SDM 10-day POI was in its infancy there were subtle changes from class to class (i.e., changes to firing events and standards) that required adjustment to our data collection efforts during live-fire training. The procedures described in the following paragraphs reflect the process followed for both courses but will emphasize the 10-day POI.

SDM Training Location and Description.

The SDM course conducts its training on Easley Range, at Fort Benning, GA. Easley Range is a known-distance range that is approximately 66 yards wide by 600 yards long and consists of a target pit, firing lines, and firing points. The target pit is located at one end of the range and is the “0” line for measurement of the firing lines. The target pit contains 26 manually operated target lifters on which the target boards are placed and raised to expose the target for the student to shoot at and lowered to mark the shot impact. The firing lines are low earthen berms that stretch the width of the range and are located at 100 yard intervals from 100 to 600 yards away from the target pit. Each firing line is subdivided into 26 firing points, one for each target lifter. The students occupy their designated firing point on each firing line to conduct training.

For the SDM conduct of fire, the number of students attending the course is first divided into equal halves; each half is called a relay and designated alpha (A) or bravo (B). A pair of students is assigned to each firing point from which they will shoot throughout the course, with one student firing in the A relay and the other firing in the B relay. For example, when combining firing point and relay, student “Smith” is 5A (fifth firing point “A” relay), and student “Jones” is 5B (fifth firing point “B” relay). At the beginning of the shooting session one relay goes to the firing line and the other relay goes to the target pit to operate the targets. At the completion of the daily shooting events for one relay a pit change occurs, allowing the relays to switch. For example, “A” relay fires first with “B” relay in the target pit, followed by a pit change after which “B” relay then fires second with “A” relay in the target pit. When both relays have shot all events, training is complete for the day.

Each day of training required the students to shoot from different distances under different conditions. For example, Day-3 training events required the student to shoot from the 500, 400, 300, 200, and 100-yard lines. The students started at the 500-yard line, shot 10 single shots slow fire, two 5-round groups, and 10 controlled pairs at timed exposure targets. Once all firing at that yard line was complete, students moved to the appropriate yard line for the next iteration of shooting. On average, the students spent 3 to 4 hours shooting, expending a minimum of 120 rounds per day. Throughout the training, students are provided extensive small group training and one-on-one instruction by the AMU instructor team. A single instructor is typically paired with a group of five students, allowing for extensive individual observation of shooting behaviors and performance throughout the day of training. In addition, instructors typically remain with that student group throughout the course, providing instructors the opportunity to learn more about the individual firer’s habits and specific areas of weakness. Two or three additional instructors not assigned to a particular section are also available on the firing line to provide additional input and help solve particularly persistent or challenging training issues.

Data Collection. Our data collection effort spanned both classroom and live-fire events. The classroom portion of our data collection effort was focused on administering the background questionnaire and the marksmanship prior knowledge test. The live-fire portion of the effort focused on collecting shooting performance data as well as instructor-to-student interactions and remediations. This interaction and remediation data will be treated in a separate research report (Lipinski, James, & Dlubac, in preparation) and is not tied to the issues under consideration here.

Classroom Data Collection. The first day of each SDM class contained an administrative portion, a 3-hour block of classroom training emphasizing the marksmanship knowledge required to successfully complete the course, and a live-fire portion where the students conducted an initial 25-meter zero. Through our coordination with the USAMU we were able to integrate our data collection effort into the administrative portion of the first day. Each class collection effort began with the administrative requirements for data collection (introduction to the research purpose, informed consent, and privacy act), followed by the administration of the background questionnaire and marksmanship prior knowledge test. Data was also provided from the Mid-Course Exam, the first multiple-choice written exam administered as part of the SDM course after the first week of instruction.

As previously stated, the background questionnaire contained five attitudinal questions designed to elicit a response relating to the students level of motivation, dread, interest, excitement, and course importance (see items 14, 15, 17, 18, and 21 in Appendix B). The responses to each question were tabulated to determine a sum value with item 15 (dreading the course) reverse coded to yield a total motivation score, where lower scores indicate greater motivation and less apprehension. The motivation scores were then categorized as low, medium, or high. For the first class, three groups of five students (total $n = 15$) were then selected, with the groups balanced by including at least one high motivation and one low motivation student in each group. The groups were also roughly equated on the overall group mean motivation score as much as possible. The aim of this process was to sample as wide a range of Soldier motivation levels as possible should that factor be related to course performance. This process was repeated for four groups for both the second and third class (total $n = 40$). The observed groups were generally placed either in the first five firing points (usually 5 – 9 A and B relays) or on the last five firing points (20 – 24 A and B relays) for ease of observation and shot data collection, but could differ based on number of students in attendance. One selected student was dropped from the course, leading to a final total of 54 participants.

Live-fire Data Collection. The target pit collection effort focused on capturing live-fire student shooting performance data from 5 different shooting events: 300-yard Iron Sights (300 Irons), 400-yard Iron Sights (400 Irons), 400-yard Optics, 500-yard Optics, 600-yard Optics. The SDM course students also completed a culminating, unknown distance firing event. This event required students to put into practice all the skills they had learned to that point – target acquisition, distance and environmental determination, and engagement techniques. This event took place on a computerized machine gun range with single and multiple target banks arrayed from 100 to 800 meters. The course of fire for this event exposed single targets at a single distance or multiple targets at multiple distances. The students were allowed one practice before completing the course of fire for record. We collected the scores from both the practice event in “slick” (without full body armor) and record fire event in “kit” (with full body armor), yielding a total of seven shooting events.

Results and Discussion

Written tests. Table 3 shows the distributions for the Prior Knowledge Short Form and Prior Knowledge Long Form results. The means and performance spreads suggest that both the Short and Long forms are sensitive to differences in Soldier marksmanship knowledge and not

subject to either floor or ceiling effects. They therefore meet a principal requirement as a potentially valid predictor of marksmanship performance. The lower overall scores for the Long Form relative to the Short Form likely reflect the greater difficulty of the test questions, including those probing the relationship between front sight MOA adjustments and round strike location (height displacement: 17% correct; right-left displacement: 30% correct) and Advanced Combat Optical Gunsight (ACOG) reticle aiming point (44% correct).

Table 3
Written Tests

Graded Event	<i>n</i>	<i>M (%)</i>	<i>SD (%)</i>
Prior Knowledge Short Form	54	76	18
Prior Knowledge Long Form	54	57.5	16.1
Mid-Course Exam	54	83.4	9

Table 3 also shows results from the Mid-Course Exam. As with both the Prior Knowledge forms, the mean and spread of performance on the mid-course written exam suggest that while the vast majority passed the exam, it was still sensitive to differences in student knowledge. Differences between the Prior Knowledge and the Mid-Course exam with respect to timing and content preclude a direct comparison of the results. Detailed, item-by-item Mid-Course Exam results are not provided here to insure the security of test content for future classes. Ninety-six percent of the Soldiers in the SDM course met or exceeded the passing score of 70% correct (see Table 4).

Shooting performance. Table 4 shows the means and standard deviations for the seven graded shooting events of the SDM course as well as the percentage of passing scores. The results reflect a broad range of performance, indicating that the shooting events were able to differentiate levels of marksmanship skill. As expected, the profiles also suggest performance decrements with increasing distance and performance improvement with the introduction of magnifying optics (compare 400 Irons and 400 Optics). Likewise, shooting performance was better when firing “slick” rather than when firing in “kit.” In evaluating the comparatively elevated performance of the Unknown Distance events (both slick and kit), two points should be made. First, the two unknown distance events include targets ranging from 100 to 800 meters. The higher hit percentages for these events may therefore be attributed at least in part to the presence of closer (and thus easier) targets. Second, the unknown distance shooting events occur on the last day of training. The performance in these events, therefore, also likely reflects an increased level of proficiency relative to the graded events shot earlier in the course.

Table 4
Passing Rates

Graded Event	Percent (%) Passing	Passing Criterion	<i>M</i> (%)	<i>SD</i> (%)
Mid-Course Exam	96.3	70% correct	83.4	9
300 Irons	59.3	60% hit	60.5	17
400 Irons	25.9	60% hit	48.2	18.4
400 Optics	81.5	60% / 50% hit *	70.2	14.5
500 Optics	79.6	50% hit	61.6	14.4
600 Optics	62.9	40% hit	52.8	16.4
Unknown Distance (slick)	100	50% hit	85.6	13
Unknown Distance (kit)	98	50% hit	80.3	13.7

* Event passing criterion changed from 60% to 50% in SDM class 12-3.

The critical motivator for the present research is determining whether measures of prior knowledge in marksmanship are predictive of later marksmanship performance. The presence of a consistent and meaningful relationship between the prior knowledge measures and the graded shooting events would suggest that prior knowledge may be an effective predictor tool, which could be used for grouping individuals and tailoring training according to the needs of that specific group. In contrast, failure to find such a relationship would indicate that prior knowledge would not be an effective tool to group individuals for the purposes of tailoring marksmanship training.

Prior Knowledge and Shooting Performance. Table 5 shows the correlations among the Prior Knowledge tests, the graded events, and the selected background factor, shooting outside the military. Although, the full set of correlations is provided here, our focus is chiefly on those elements directly relevant to prior knowledge and tailored training. Nonetheless, two general observations from the correlations are worth noting. First, both the Short and Long forms of the Prior Knowledge test are significantly correlated with the Mid-Course Written Exam. This makes sense given that both the Prior Knowledge test and the Written Exam should tap some overlapping areas of marksmanship knowledge. While the correlation is moderate, this likely reflects the course-specific focus of the Written Exam; the Prior Knowledge forms are intentionally broad in their coverage and are not intended to test the knowledge of SDM-specific material. Second, both forms of the Prior Knowledge test are also moderately correlated with shooting experience outside of the military. This too should be expected because shooting experience necessarily involves some exposure to basic marksmanship concepts and terminology. The moderate strength of the relationship likely reflects the Prior Knowledge content that goes beyond traditional recreational shooting experience, again consistent with the intent of the Prior Knowledge forms. These observations support the use of the Prior Knowledge forms as valid measures of marksmanship knowledge.

Prior Knowledge Short Form and Shooting. Figure 1 highlights the pattern of correlations between the Prior Knowledge Short Form and the graded shooting events. The overall pattern of relationships is notably strong, with the Prior Knowledge Short Form significantly correlated with performance in six of the seven shooting events (i.e. all except 500 Optics). Moreover, the r values range from 0.28 (400 Iron Sights) to 0.65 (300 Iron Sights), and thus account for a behaviorally relevant proportion of the variance (an average of 17% across the significant measures with a high of 42% for 300 Iron Sights). This pattern is particularly impressive given the differing distances and optics of the measured events. In addition, it is important to note that the graded events spanned the entire course from Day 1 (300 Iron Sights) through Day 10 (Unknown Distance events). The predictive power of the Prior Knowledge Short Form thus generalizes beyond a single event and even over the changing levels of knowledge and experience arising through the course. Indeed, given that Soldiers in the SDM course are provided extensive one-on-one training from SDM instructors and “trigger time,” one might expect that shrinkages in the range of performance alone would significantly dampen or outright eliminate the correlations. This was not the case.

Although shooting outside of the military did not exhibit the same consistency of relationships with the shooting events (see Table 5), it is nonetheless important to determine whether the Prior Knowledge tests account for variance beyond that possibly attributable to non-military shooting activities and experience. If the Prior Knowledge tests do not significantly account for additional variance beyond that linked to shooting outside of the military, then they will not serve as a useful performance predictor; administering a written exam is more time consuming than simply asking Soldiers if they shoot weapons outside of the military setting.

Figure 2 highlights the pattern of correlations between the Prior Knowledge Long Form and the graded shooting events. The overall pattern is similar to that for the Prior Knowledge Short Form (Figure 1), due in part to its incorporation of that content. Comparable to the Short Form results, the Long Form r values ranged from 0.21 to 0.41 and were significant for five of the seven events (i.e., all except 400 Optics and 500 Optics), accounting for an average of 12.7% of the variance in those significantly related events.

To answer this question, we used a multivariate analysis of variance (MANOVA), with all seven of the shooting events together serving as the set of dependent variables, and Shooting Outside the military and the Prior Knowledge Short Form as the predictors. Results indicated that the Prior Knowledge Short Form significantly predicted shooting performance, Wilks' $\lambda = 0.47$, $F(7,45)$, $p < .001$ in the presence of Shooting Outside, which itself did not predict collective shooting performance, Wilks' $\lambda = 0.85$, $F(7,45)$, $p = 0.37$. The Prior Knowledge Short Form results therefore, uniquely account for variance in shooting performance. The results for the Prior Knowledge Long Form aligned with these results, yielding a significant relationship between the Prior Knowledge Long Form and shooting performance, Wilks' $\lambda = 0.72$, $F(7,45)$, $p = 0.02$ in the presence of Shooting Outside, which itself did not predict collective shooting performance, Wilks' $\lambda = 0.82$, $F(7,45)$, $p = 0.23$.

Table 5

Correlations among Prior Knowledge, Graded Events, and Shooting Outside the Military

	300 Irons	400 Irons	400 Optics	500 Optics	600 Optics	Unknown Distance Kit	Unknown Distance Slick	PK Short Form	PK Long Form	Mid- Course Exam	Shooting Outside
300 Irons	—	0.46***	0.4**	0.25	0.45***	0.16	0.32*	0.65***	0.41**	0.46***	0.08
400 Irons	0.46***	—	0.42**	0.41**	0.48***	-0.03	0.38**	0.28*	0.35*	0.4**	0.16
400 Optics	0.4**	0.42**	—	0.6***	0.72***	0.1	0.28*	0.29*	0.23	0.46***	0.13
500 Optics	0.25	0.41**	0.6***	—	0.5***	0	0.24	0.24	0.21	0.29*	0.31*
600 Optics	0.45***	0.48***	0.72***	0.5***	—	0.09	0.19	0.49***	0.32*	0.45***	0.31*
Unknown Distance Kit	0.16	-0.03	0.1	0	0.09	—	0.54***	0.31*	0.28*	0.32*	0.01
Unknown Distance Slick	0.32*	0.38**	0.28*	0.24	0.19	0.54***	—	0.32*	0.41**	0.36**	0.05
PK Short Form	0.65***	0.28*	0.29*	0.24	0.49***	0.31*	0.32*	—	0.65***	0.53***	0.3*
PK Long Form	0.41**	0.35*	0.23	0.21	0.32*	0.28*	0.41**	0.65***	—	0.47***	0.36**
Written Exam	0.46***	0.4**	0.46***	0.29*	0.45***	0.32*	0.36**	0.53***	0.47***	—	0.28*
Shooting Outside	0.08	0.16	0.13	0.31*	0.31*	0.01	0.05	0.3*	0.36**	0.28*	—

* $p < .05$. ** $p < .01$. *** $p < .001$.

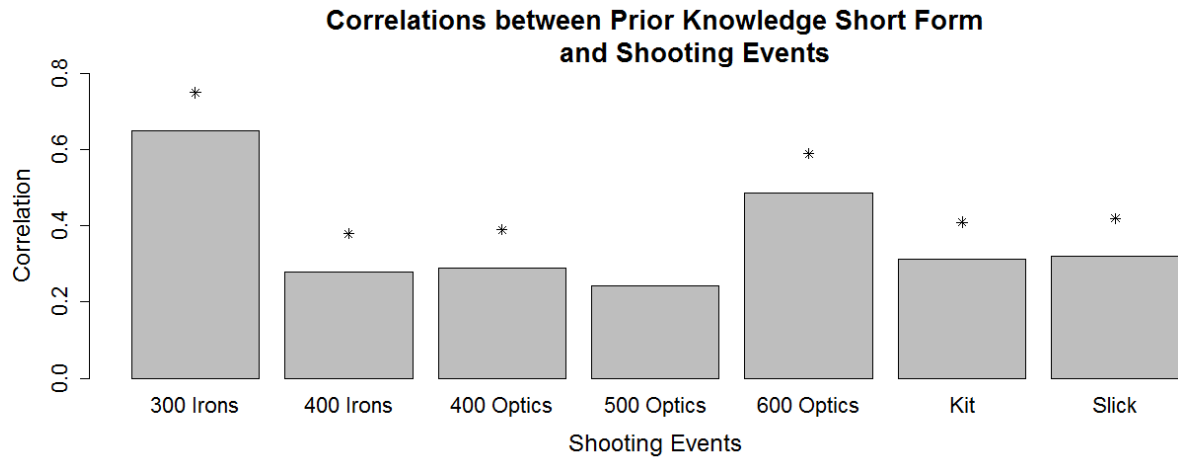


Figure 1. Correlations between the Prior Knowledge Short Form and the shooting events. * $p < .05$.

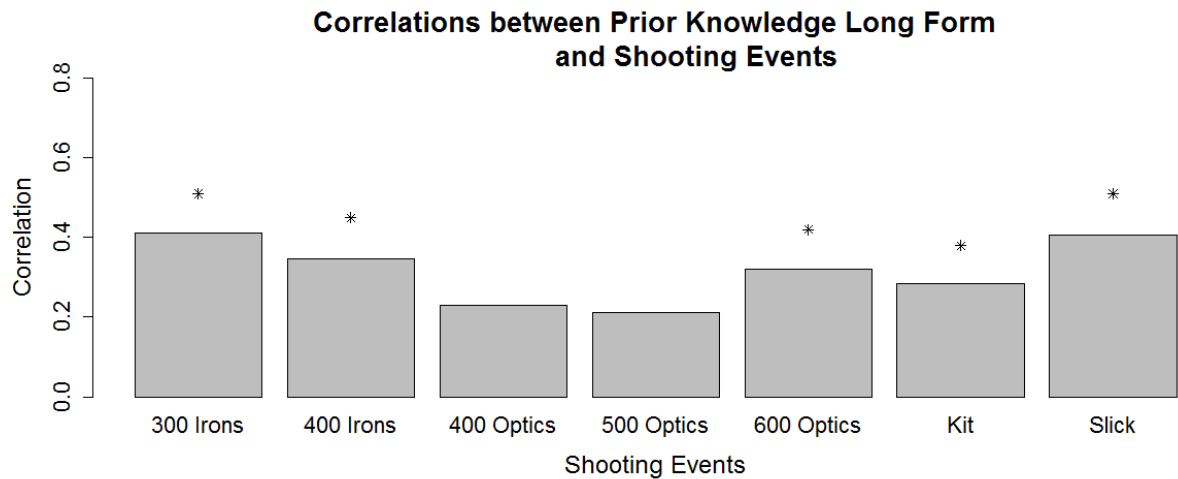


Figure 2. Correlations between the Prior Knowledge Long Form and the shooting events. * $p < .05$.

These results support three specific conclusions. First, the pattern of relationships between two forms of the Prior Knowledge test and the graded events from the SDM course (both written and shooting) suggests that both the Short and Long Form versions are valid measures of prior marksmanship knowledge. Second, there is a broadly consistent and robust relationship between the Prior Knowledge tests and shooting performance across distances and time points in the course. This relationship was particularly prominent for the Short Form, further supporting its potential as a predictive measure appropriate for instructional grouping. Third, Prior Knowledge significantly accounts for differences in shooting performance even after accounting for variance attributable to non-military shooting experience. Indeed, and perhaps somewhat surprisingly, Shooting Outside did not significantly predict shooting performance. In simplest and practical terms, knowing whether or not a Soldier shoots outside a military context is not predictive.

The evidence to this point suggests that the Prior Knowledge tests may potentially serve as performance predictors that could be used to assign individuals to differing instructional groups. It is important to note, however, that the results to this point are based on a unique, generally more experienced Soldier sample. While the tests might certainly serve as a predictor of performance in the SDM Course, it would be far more useful to determine whether the Prior Knowledge Short Form or Long Form tests could serve to inform instructional group assignment in BRM training, where it can maximally benefit Army instruction and training effectiveness. To answer this, we turn now to Experiment 2.

Experiment 2

The results of Experiment 1 indicate that the Prior Knowledge tests are predictive of marksmanship performance in the SDM Course over and above any simple predictive effects tied to shooting outside of a military context. To test for the potential benefit of this Prior Knowledge test as a predictive tool appropriate for instructional grouping, Experiment 2 tested for the relationship between the Prior Knowledge assessment and performance on the qualification course of fire for Soldiers in initial entry training. Evidence supporting a strong relationship between the Prior Knowledge test and record qualification performance would support its use to form instructional groupings, potentially increasing the efficiency and effectiveness of BRM training.

Method

This experiment required the administration of the Prior Knowledge test and the collection of firing data, which was accomplished with an Infantry One Station Unit Training (OSUT) company at Fort Benning, GA in March 2013. The experiment required a three phased approach – pre-testing, firing data collection, and post-testing. (Note: The pre- and post-tests were the identical Prior Knowledge Long Form test.) Due to normal attrition and training attendance the number of Soldiers differs from initial testing to firing data collection to post testing.

Participants

The Infantry OSUT training company had 203 Soldiers assigned at the beginning of the experiment. All Soldiers completed the pre-test, 191 Soldiers completed a practice record fire qualification event (BRM 9), and 195 completed the post-test. Complete data sets – pre-test, firing data, post-test – exist for 184 Soldiers. We did not collect motivation data from those participating in Experiment 2 because motivation was not significantly related to performance in Experiment 1 and motivation is not central to the present research question.

Procedures

Researchers collected data for the three events based on the OSUT company's training calendar – pre-test, firing data collection, and post-test.

Pre-test. The pre-test was administered for two purposes: (1) to assess the Soldier's marksmanship knowledge and (2) to determine the validity of the pre-test predictor efficacy. The research design called for two platoons (half of the company) to be administered the pre-test prior to BRM 1, that is, prior to any marksmanship training. These platoons are referred to as the "early" group. The other two platoons were to be administered the pre-test after BRM 3, that is, after fundamental marksmanship training was conducted, but prior to any live fire shooting. These platoons are referred to as the "late" group. This was designed to identify any differences in the predictor strength based on scheduled marksmanship training. One research team member administered the pre-test to the Soldiers in a classroom environment in their company area. The process lasted approximately 30 minutes including time for the team member to check each test for completeness.

Firing data collection. The purpose of collecting firing data was to compile a data set to determine any predictor effects between pre-test scores and firing results. During initial coordination, the unit was made aware of the research team's desire to collect firing data from two periods of instruction – BRM 9 (Practice Record Fire) and BRM 10 (Record Fire). These events are conducted on a live-fire pop-up target range where Soldiers have to engage 40 targets with 40 bullets and score a minimum of 23 hits to qualify. Data collection consisted of one research team member recording each Soldier's score as they completed the event. In the case of Soldiers repeating the event, all scores for each Soldier were captured. The present analyses focused solely on BRM 9 because it is the first exposure to the qualification course of fire in the BRM training plan. BRM 9 therefore stands as a cleaner test of the relationship between the qualification course of fire performance and Prior Knowledge because it is not complicated by any practice effects as would be the case for the following final record qualification performance period, BRM 10.

Post-test. The purpose of the post-test was to determine knowledge acquisition over the course of BRM training. Post-tests were administered in the same fashion as pre-tests with one team member administering the test after the completion of the BRM periods of instruction.

Results and Discussion

Prior Knowledge. Table 6 shows the means and standard deviations for the Prior Knowledge pre- and post-tests. As expected, the Prior Knowledge Short Form percentages were generally higher than those for the Long Form, consistent with the more advanced knowledge tested in the Long Form version. In addition, comparison of the Short Form pre-test ($M = 5.88$; 65.3%) and post-test ($M = 6.82$; 75.8%) scores suggests that Soldiers increased their knowledge of marksmanship knowledge as a result of BRM training. We also observed a comparable increase between the pre-test ($M = 11.2$; 44.8%) and post-test ($M = 13.8$; 55.2%) for the Long Form. Follow-up paired-samples t -tests for the Short Form ($t(183) = 7.02, p < .01$) and the

Long Form ($t(183) = 11.11, p < .01$) confirm statistically significant improved performance on both forms of the Prior Knowledge test. An additional paired samples t -test examining change in performance on those questions unique to the Long Form (i.e., excluding the Short Form items that are included in the Long Form) was also significant, $t(183) = 10.08, p < .01$. This shows that the significant improvement in Long Form tests cannot be solely attributed to improvement on the Short Form portion of the Long Form test.

Table 6
Comparison of Test Scores

Graded Event	<i>M</i>	<i>SD</i>	<i>M (%)</i>	<i>SD (%)</i>
Pretest PK Short Form	5.88/9	1.78	65.3	19.8
Posttest PK Short Form	6.82/9	1.54	75.8	17.1
Pretest PK Long Form	11.2/25	4.15	44.8	16.6
Posttest PK Long Form	13.8/25	3.4	55.2	13.6

We also tested for differences between those taking the Prior Knowledge test before the start of BRM 1 versus those taking the Prior Knowledge test after completing BRM 3 (Table 7). Results indicate that those taking the Prior Knowledge test after BRM 3 scored significantly higher than those taking the test earlier for both the Short Form (Welch's t -test, $t(178.75) = 5.54, p = .011$) and the Long Form (Welch's t -test, $t(181.43) = 5.17, p < .001$). The most reasonable interpretation is that those taking the test later scored higher simply because they received some marksmanship instruction before completing the test. However, it is important to also keep in mind that the timing of the test (early v. late) was not randomly assigned, but instead varied with their platoon assignment and, consequently, platoon instructors. Multiple test administrations within a platoon would have disrupted the training and was not feasible. Given the confound between instructor and test administration timing, these and any subsequent differences between the early and late testers should be interpreted with caution.

Table 7
Comparison of Prior Knowledge Test Scores by Group

	Prior to BRM (Early Group)	After BRM3 (Late Group)	Difference
PK Short Form	5.6/9	6.2/9	0.6*
PK Long Form	9.9/25	12.6/25	2.7**

* $p < .05$. ** $p < .01$.

As an additional gauge of learning over BRM training, we examined changes in Prior Knowledge test performance from initial testing to completion of BRM training. Table 8 shows the changes in score for those in the Early Group. The results for both the Short Form and the Long Form versions show a modest but significant gain in marksmanship knowledge.

Table 8
Changes in Prior Knowledge Test Scores: Early Group

	Prior to BRM	After BRM10	Difference
PK Short Form	5.6/9	7/9	1.4**
PK Long Form	9.9/25	14/25	4.1**

** $p < .01$.

Table 9 shows comparably modest but statistically significant changes in both the Short and Long Form versions for those in the Late Group. Together, these results indicate that students acquire additional knowledge of marksmanship concepts throughout the BRM training periods, although the gains themselves are limited in absolute terms.

Table 9
Changes in Prior Knowledge Test Scores: Late Group

	After BRM3	After BRM10	Difference
PK Short Form	6.2/9	6.7/9	.5*
PK Long Form	12.6/25	13.6/25	1*

* $p < .05$.

Shooting Performance. The mean number of hits for BRM 9 was 29.7 (SD = 5.3) out of a possible 40 (Mean hit rate = 74.3%; SD = 13.2%). Nearly 90% (89.1%) of the Soldiers met the qualifying standard of 23 hits. This performance is generally in line with that recently reported for record fire qualification (see F-2 and F-3 in Dyer et al., 2010), although the differences between BRM 9 and true record fire in addition to any possible training differences preclude a direct comparison.

Prior Knowledge and Shooting Performance. The critical question is whether Prior Knowledge significantly predicts shooting performance for Soldiers in BRM training. Table 10 shows the correlations separately for the Early and Late Groups, revealing an inconsistent pattern of relationships. For example, there is a significant correlation between Shooting Outside and BRM 9 performance for those in the Late Group but not in the Early Group, although nothing about the administration of the Prior Knowledge test could reasonably influence this relationship.

Table 10
Correlation of Prior Knowledge by Groups

	Group	BRM 9	Shooting Outside	PK Long Form	PK Short Form
BRM 9		--			
Shooting Outside	Early	0.1	--		
	Late	0.22*	--		
PK Long Form	Early	0.19	0.4***	--	
	Late	0.27*	0.35***	--	
PK Short Form	Early	0.2	0.24*	0.82***	--
	Late	0.13	0.27*	0.67***	--

* $p < .05$. ** $p < .01$. *** $p < .001$.

Given this broadly inconclusive pattern, we subsequently collapsed across the Early and the Late Groups to increase the sensitivity of tests for relationships between Shooting Outside, Prior Knowledge, and BRM 9 performance (see Table 11).

Table 11
Correlation of Prior Knowledge: All Participants

ALL	BRM 9	Shooting Outside	PK Long Form	PK Short Form
BRM 9	--			
Shooting Outside	0.16*	--		
PK Long Form	0.24**	0.32***	--	
PK Short Form	0.18*	0.23**	0.75***	--

* $p < .05$. ** $p < .01$. *** $p < .001$.

There are two observations of note. First, consistent with the Experiment 1 SDM course results, Experiment 2 shooting performance was significantly correlated with Shooting Outside and with Prior Knowledge. This is notable because the SDM course draws from an experienced Soldier population while those in Infantry OSUT are typically inexperienced. The significant Shooting Outside and Prior Knowledge measures therefore signal that these measures are somewhat robust to changes across different Soldier populations. Second, this relation between Prior Knowledge, Shooting Outside, and marksmanship are also somewhat robust to changes in course of fire. In the case of the BRM rifle qualification, targets appear at distances between 50 meters and 300 meters. By contrast, the SDM marksmanship measures focused exclusively on longer range targets, between 300 yards (274 meters) and 600 yards (549 meters). Both paper-and-pencil Prior Knowledge tests retained a significant relationship to marksmanship over these substantial changes in courses of fire.

We are careful to note, however, that the magnitude of the correlation between Prior Knowledge and marksmanship performance in Experiment 2 (Long Form $r = 0.24$; Short Form $r = 0.18$) is somewhat lower than that observed in Experiment 1 (from $r = 0.28$ to $r = 0.65$). One possible explanation is the number of close targets in the BRM qualification course of fire. For the SDM course, 300-yard target performance had the strongest correlation with the Prior Knowledge measures. Target distances in the BRM qualification course of fire, on the other hand, vary between 50-meter and 300-meter, with only three of the 40 targets at this maximum distance. Indeed, it is reasonable to believe that hitting closer targets may be achieved even with somewhat limited marksmanship skills and knowledge of BRM concepts, relative to more distant targets which are less forgiving of shooter error. Additional detailed considerations are beyond the scope of the present paper and can only be definitively addressed by examining target-by-target shooting data which was not available.

Given the observed significant correlations, we next tested whether the Prior Knowledge measures maintained a significant predictive relationship with BRM 9 shooting performance even after accounting for variance attributable to Shooting Outside. Table 12 shows the results of BRM shooting performance regressed on Prior Knowledge (Short Form) raw scores and Shooting Outside (collapsing across the early and late groups). The results indicate a modest but statistically significant relationship between the Short Form measure and shooting performance when controlling Shooting Outside, which did not itself significantly predict shooting performance. Translating the Short Form regression coefficient (1.1) into real terms, however, reveals that each additional correct answer on the 9-item Short Form test only contributes to an approximate 1% increase in hit percentage (or about 1 additional target hit for every two additional correct answers).

Table 12
Regression of Shooting Performance with Prior Knowledge (Short Form)

	Estimate	SE	t	p
Intercept	66.24	3.32	19.97	<.001
Shooting Outside	3.22	1.97	1.64	0.103
PK Short Form	1.10	0.55	1.98	0.049

Note: $R^2 = .045$.

Table 13 reveals a significant but comparably modest relationship between the Long Form Prior Knowledge raw score and shooting performance when controlling for Shooting Outside (also collapsing across early and late groups); Shooting Outside did not itself significantly predict shooting performance. Considered together, these results indicate that while both the Short and Long Form versions of the Prior Knowledge test do predict BRM 9 practice qualification performance in the strict statistical sense, the relationship is not strong enough to practically aid BRM training allocation decisions.

Table 13

Regression of Shooting Performance with Prior Knowledge (Long Form)

	Estimate	SE	<i>t</i>	<i>p</i>
Intercept	65.18	2.89	22.56	<.001
Shooting Outside	2.33	2.00	1.16	0.246
PK Long Form	0.71	0.26	2.76	0.006

Note: $R^2 = .063$

Summary

The present research examined the use of a marksmanship prior knowledge test as a means of systematically grouping Soldiers for the purposes of rifle marksmanship instruction. Evidence supporting the predictive utility of either the Long Form or the Short Form versions of the Prior Knowledge test would open the door to establishing different instructional groups based on test performance. The results of the present research were somewhat mixed, yielding a fairly strong relationship between prior knowledge and shooting performance for experienced Soldiers in the SDM course and a statistically significant but relatively weak relationship with practice qualification scores for those receiving BRM instruction. Considered as a whole, these results suggest that while some form of prior knowledge testing might be ultimately useful for instructional grouping in BRM, additional test development and research is required.

Several additional observations should nonetheless be noted. First, results from Experiment 1 showed that experience shooting outside of the military did not consistently predict shooting performance. Experiment 2 provided similar results, indicating that experience outside of the military was only modestly correlated with shooting performance. In addition, shooting outside of the military was not significantly related to shooting performance in analyses including measures of prior knowledge. This failure to find a meaningful relationship between shooting outside of the military and marksmanship performance in multiple shooting tasks is important given the intuitive link between additional task experience and better performance and its informal use as a predictor.

Why might experience shooting outside the military be at best only modestly linked with performance? One possibility is that the question is so broad that it includes those with extremely limited experience as well as those with extensive experience. A second and perhaps more likely possibility is that it fails to separate out those who have acquired solid shooting fundamentals through their experience from those who have instead developed bad habits. For those who acquired sound shooting fundamentals, previous experience should indeed contribute to better performance. For those with poor established shooting habits, however, such experience would be detrimental to shooting performance and could actually impair the acquisition of the new shooting skills required for improved performance (for related neuroscience research on learning and habits, see Ashby, Turner, & Horvitz, 2010; Ashby, Ennis, & Spiering, 2007; Huang, Hazy, Herd, & O'Reilly, 2013; Kelly & Garavan, 2005). These

questions could be best answered by a future systematic examination of the varying levels of shooting experience and the soundness of any shooting habits acquired prior to entering the Army.

A second observation is that waiting until BRM 9 to assess shooting performance (Experiment 2) may overlook meaningful differences in earlier shooting performance. In particular, while it is possible that differences in prior knowledge may impact early shooting performance, those with little shooting knowledge prior to BRM effectively catch up as training progresses. Consequently, by the time shooting performance is measured at BRM 9, any knowledge differences are likely smaller and gains from marginal additional knowledge are probably small relative to the impact of prior knowledge differences at the beginning of BRM training. Future research examining the impact of prior knowledge on marksmanship may therefore benefit from examining earlier performance indicators, especially grouping and zeroing in BRM 4 and BRM 5. Successfully predicting which Soldiers will likely struggle during the grouping and zeroing exercises may be particularly useful given the number of rounds expended during these periods and the impact that a quality zero has on subsequent shooting performance.

Finally, when considering the differences in predictive power between Experiment 1 (SDM) and Experiment 2 (BRM), it is important to consider differences in the shooting tasks. In the case of BRM 9, we note that the BRM qualification course of fire includes targets as close as 50 or 100 meters. In contrast, all the targets included in the SDM shooting assessments appeared at a minimum of 300 yards. The task of shooting longer-distance targets is considerably more difficult and requires strong adherence to shooting fundamentals. Targets appearing as close as 50 meters, on the other hand, are considerably more forgiving. In short, the SDM courses of fire may be more uniformly sensitive to tests of marksmanship skill and thus more amenable to the application of knowledge-based predictors. Future research may also wish to consider the applicability of prior marksmanship knowledge assessments for more urban shooting tasks such as those for Military Operations on Urban Terrain (MOUT). The contribution of shooting fundamentals (e.g., sight alignment and trigger control) which are indirectly tapped by prior knowledge assessments would also be expected to apply in MOUT settings as they do in SDM and rifle qualification performance.

Conclusions and Recommendations

The primary finding from the present research is that the prior knowledge predictor measure may be of value for more experienced shooters as assessed on more consistently demanding courses of fire. For typically less experienced shooters, namely those in BRM training, the prior knowledge predictor is of limited practical use. A secondary conclusion is that experience shooting outside of the Army is not consistently associated with better shooting performance for either experienced or less experienced shooters. This latter observation is notable given its common informal application in marksmanship training.

Despite the limited utility of the specific prior knowledge test examined here, the present work does reveal several additional considerations that speak directly to effective tailored training practices. First, it is important to specify the relationship between the performance measures of interest and its timing within the training. Our considerations of prior knowledge in

the context of improved knowledge and performance over training suggest that the measured relationship between prior knowledge and performance may depend at least in part on when performance is assessed. Future research should probe shooting performance at multiple points throughout training to determine how the relevance of prior knowledge measures interacts with skill acquisition over time.

Second, assessments of experience, whether formal or informal, should be sensitive to differences in the quality and applicability of that experience. In the specific case of marksmanship, it is not uncommon for experienced shooters to have acquired their basic marksmanship skills informally from family members. Because the quality of that initial experience and training can vary widely, instructors and researchers alike should be cognizant that those differences may impact performance and the ease of training. Indeed, several instructors noted that it is easier to train complete novices because they have no bad habits to break. While only anecdotal, such a view is consistent with current neuroscience research (Ashby, Turner, & Horvitz, 2010; Ashby, Ennis, & Spiering, 2007; Huang, Hazy, Herd, & O'Reilly, 2013; Kelly & Garavan, 2005).

Finally, it is important to remember that in the context of tailored training, the ability to predict performance is only valuable if it can be easily adopted by trainers with real Soldiers in a realistically constrained environment. It is instructive that the 9-item Short Form prior knowledge test was as affective in predicting SDM performance as the 25-item Long Form version. Future research would do well to develop easy-to-administer measures that quickly capture performance-relevant information because such tests are most likely to be used in demanding, high-throughput training contexts.

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Acronyms

ACOG	Advanced Combat Optic Gunsight
ATI	Aptitude-by-treatment Interaction
BRM	Basic Rifle Marksmanship
DMDC	Defense Manpower Data Center
FSD	Force Sustainment Division
MFD	Maneuver and Fires Division
MOA	Minute of Angle
NCO	Non-commissioned Officer
OSD	Operations Support Division
OSUT	One Station Unit Training
POI	Program of Instruction
SDM	Squad Designated Marksmanship
TRADOC	U.S. Army Training and Doctrine Command
USAMU	U.S. Army Marksmanship Unit

Appendix A

Summary of Student Demographics

Background Information

Please write-in, circle, or fill-in the dot (●) for each question. Where “***Other***” and a blank space are located, please write-in the information that applies (e.g. DEA).

1. Rank (n = 102)	
PV2	3
PFC	7
SPC	13
CPL	3
SGT	19
SSG	35
SFC	7
1SG	0
2LT	12
1LT	1
CPT	1
COL	1

2. Branch of Service (n = 102)	Air Force	Army
	0	102

3. Current Service Status (n = 101)	Active Duty	Active Guard Reserve (AGR)
	95	6

	Average	Range
4. Current Time in Service (n = 102)	83.4 months	6 – 290 months

5. MOS/Rating/AFSC/Branch (<i>n</i> = 102)	
11A	14
11B	38
11C	1
12B	11
12N	1
18B	2
18C	1
19D	13
19K	2
21N	1
25M	1
25U	1
27D	1
37F	4
42A	2
60N	1
74D	1
88M	4
91F	1
91H	1
91L	1

6. Number of Deployments ($n = 102$)	#
0	26
1	30
2	24
3	8
4	11
5	3

7. Year of Last Deployment ($n = 101$)	Never Deployed	Prior to 2009	2009	2010	2011
	26	15	17	29	14

8. Do you shoot right or left-handed? ($n = 102$)	Right-handed	Left-handed
	90	12

9. Are you right or left-eye dominant? ($n = 102$)	Right-eye	Left-eye
	85	17

10. Which eye do you shoot with? ($n = 161$)	Right-eye	Left-eye
	90	12

Course Attendance

12. Reason for attending the course (check (●) one)		
a	Volunteered	75
b	Directed to attend	27

14. What is your level of motivation for the course? (<i>n</i> = 102)						
Motivated				Unmotivated		
1	2	3	4	5	6	7
82	16	3	1	0	0	0

15. To what extent are you dreading the course? (<i>n</i> = 102)						
Dreading it				Looking forward to it		
1	2	3	4	5	6	7
1	0	2	2	7	12	78

17. What is your level of interest in the course? (<i>n</i> = 101)						
Interested				Uninterested		
1	2	3	4	5	6	7
88	11	1	1	0	0	0

18. To what degree are you excited about the course? (<i>n</i> = 101)						
Excited				Not Excited		
1	2	3	4	5	6	7
75	17	6	2	0	0	1

19. Are you familiar with training delivered by the Army Marksmanship Unit (AMU)? (<i>n</i> = 100)		Yes	No
		26	74

21. How important is SDM training to you? (<i>n</i> = 102)						
Important				Unimportant		
1	2	3	4	5	6	7

79	18	2	3	0	0	0
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Equipment

22. What type of rifle will you use for the course? (<i>n</i> = 97)	M16A4	M4 MWS	AMU SDM Rifle	M110
	6	40	50	1

23. Is the rifle you will use your assigned rifle? (<i>n</i> = 102)	Yes	No
	33	69

24. What type of sights/optics will you use during the course (<i>multiple response per student</i>)		
a	Carrying handle iron sights	4
b	Backup iron sights	66
c	Close Combat Optic (CCO)	4
d	Advance Combat Optical Gunsight (ACOG)	51
e	EO Tech	1
f	Rifle Combat Optic (RCO)	0
g	Elcan	2
h	Leopold Scope	50
i	S&B Short Dot	1

25. Is this the first time you have shot with this type of optic? (<i>n</i> = 90)	Yes	No
	37	53

Marksmanship Experience

26. Do you engage in any type of rifle shooting outside of military service (circle one)	52	50
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If <u>Yes</u>, check (●) the frequency for each type. If <u>No</u>, leave blank		Hunting	Recreational	Competitive
a	Not within the last 12 months	7	4	7
b	Once or twice within the last 12 months	8	15	1
c	3 to 10 times within the last 12 months	7	17	2
d	More than 10 times over the last 12 months	8	14	2

27. Which military weapons have you fired extensively (e.g. qualified with, used during deployments, etc.) in your military career? (check (●) all that apply)		
a	M9 Pistol	54
b	M21 or M24 Sniper Rifle	7
c	M107 Sniper Rifle	5
d	M249 SAW	58
e	M240B/M60 Machine Gun	71
f	M2HB Machine Gun	42
g	MK19 Grenade Machine Gun	35

28. Rifle Marksmanship Courses Attended (check (●) all that apply)		
a	U.S. Army Sniper School	0
b	Marine Corps Scout Sniper Training	0
c	Special Operations Target Interdiction Course	3

29. When was the last time you fired a military service rifle? (check (●) one) (n = 102)		
a	Less than 1 week	12
b	Less than 1 month	33
c	Less than 6 months	44
d	Greater than 6 months	8
e	In Basic Training/Boot Camp/Basic Officers Leader Course only	5
f	I have never fired a military service rifle	0

30. How many times have you fired a military service rifle in the last 12 months? (check (●) one) (n = 102)		
a	I have never fired a military service rifle	0
b	Have not fired a military service rifle in the last 12 months	0
c	Once or twice	20
d	3 to 10 times	40
e	More than 10 times	42

31. When was the last time you grouped and zeroed a military service rifle? (check (●) one) (n = 102)		
a	Less than 1 week	5
b	Less than 1 month	25
c	Less than 6 months	41
d	Greater than 6 months	26
e	In Basic Training/Boot Camp/Basic Officers Leader Course only	5

32. How many times have you grouped and zeroed a military service rifle in the last 12 months? (check (●) one) (n = 102)		
a	Have not grouped and zeroed a military service rifle in the last 12 months	3
b	Once or twice	50
c	3 to 10 times	39

d	More than 10 times	10
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33. What was your last rifle qualification score rating? (check (●) one) (n = 99)		
a	Expert	59
b	Sharpshooter	30
c	Marksman	10

34. When was your last rifle qualification? (check (●) one) (n = 99)		
a	Within last 6 months	56
b	6 – 12 months ago	39
c	Longer than 12 months ago	4

Thank you for your participation.

Appendix B

Marksmanship Prior Knowledge Test

Date _____

Rank _____

Last Name _____

Matching

Directions: On the line to the left of each definition, write the letter of the term which best matches the definition. Each term may be used only once. There are more terms than definitions.

Definition	Term
_____ 1. The firm consistent contact of the cheek with the rifle's butt stock	a. Stable firing position
_____ 2. The relationship between the front sight post, rear sight aperture, and the aiming eye	b. Eye relief
_____ 3. The body's skeletal structure supporting the rifle's weight	c. Firing hand placement
_____ 4. The point in the breathing cycle during which the body is most relaxed, allowing the sights to settle at the natural point of aim	d. Firm pistol grip
_____ 5. The skillful manipulation of the trigger that causes the rifle to fire without disturbing sight alignment or sight picture	e. Follow-through
_____ 6. Positioning of the "V" formed between the thumb and index finger of the firing hand	f. Wobble area
_____ 7. Continued application of the fundamentals until the round has exited the barrel	g. Natural respiratory pause
_____ 8. The process used to adjust the rifle sights that causes the rifle to shoot at the point of aim at a desired range	h. Recovery
_____ 9. The movement of the front sight around the point of aim	i. Sight adjustment
	j. Sight alignment
	k. Bone support
	l. Stock weld
	m. Trigger control

Multiple Choice

Directions: Circle the answer you select.

10. A bullet flying through the air is acted upon primarily by two forces which change the direction and velocity of its motion. These two forces are?
- a. Temperature and Humidity
 - b. Elevation and Friction
 - c. Bullet Weight and Caliber
 - d. Gravity and Air Resistance
 - e. I don't know
11. The path of flight that the bullet will take when it is fired from the rifle is known as what?
- a. Max ordinance
 - b. Trajectory
 - c. Terminal ballistics
 - d. Physics
 - e. I don't know
12. What happens when a bullet leaves the bore of the rifle in which the barrel is horizontal to the ground and the line of sight is parallel to the line of bore
- a. It will fly straight until it hits the target
 - b. It will go up due to its aerodynamic properties
 - c. It will immediately begin to fall to the earth
 - d. It depends on the Ballistic Coefficient
 - e. I don't know
13. How many times will the bullet cross your line of sight before it hits the target when engaging a 350 yard target with a 300 yard Battle Sight Zero while aiming center mass?
- a. Once
 - b. Twice
 - c. Three times
 - d. It won't cross at any time
 - e. I don't know
14. 1 minute of angle (MOA) @ 100 yards = 1 inch
- a. True
 - b. False

15. 6 inches @ 600 yards = ____ MOA

- a. 6
- b. 2
- c. 1
- d. I don't know

16. 5 MOA @ 200 yards = ____ inches

- a. 15
- b. 10
- c. 5
- d. I don't know

17. If the accuracy of the M4 with M855 (green tip) ammunition is 3 MOA, what size group is the rifle/ammunition combination capable of shooting at 400 yards?

- a. 9 inches
- b. 12 inches
- c. 15 inches
- d. 18 inches
- e. I don't know

18. One quarter turn (1 click) of the M16A4 front sight post equals $1\frac{1}{4}$ MOA. How many clicks does it take to move the strike of the round 10 inches down @ 400 yards?

- a. 2 clicks counter clockwise
- b. 2 clicks clockwise
- c. 3 clicks counter clockwise
- d. 3 clicks clockwise
- e. I don't know

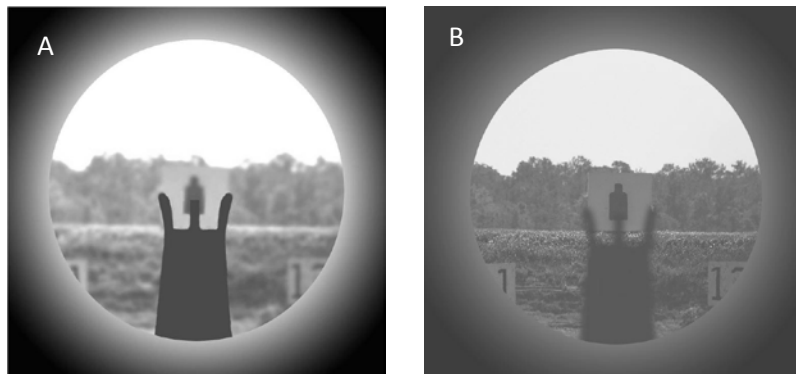


19. One click of the backup iron sight on the M4 rifle equals $\frac{3}{4}$ MOA. How many clicks does it take to move the strike of the round 6 inches right at 100 yards?

- a. 6 clicks counter clockwise
- b. 6 clicks clockwise
- c. 8 clicks counter clockwise
- d. 8 clicks clockwise
- e. I don't know



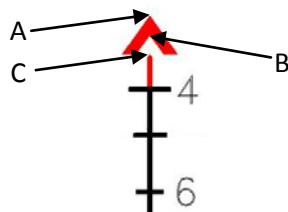
20. Which sight picture is correct when firing the rifle with iron sights?



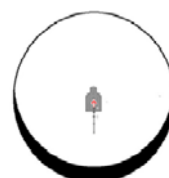
- a. A
- b. B
- c. Both A and B
- d. Neither A nor B
- e. I don't know

21. What is the correct aiming point on the ACOG reticle when zeroing at 100 yards?

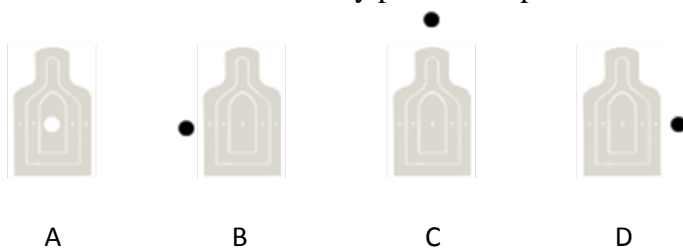
- a. A
- b. B
- c. C
- d. None of the above
- e. I don't know



22. If your field of view through the ACOG resembled this:



Where would the most likely point of impact be located?



- a. A
- b. B
- c. C
- d. D
- e. None of the above
- f. I don't know

23. If 1 click of elevation and windage on the ACOG = $\frac{1}{3}$ MOA, how far will 1 click move the strike of the round @ 300 yards?

- a. $\frac{1}{3}$ inch
- b. 1 inch
- c. 3 inches
- d. I don't know

24. When reading the wind you want to focus on conditions...?

- a. At your position
- b. Behind the target
- c. Half way to two thirds to the target
- d. At the target
- e. I don't know

25. If the target is moving with the wind you must ____ the wind value from your lead?

- a. Add
- b. Subtract
- c. I don't know